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Fabrication of Air Engine

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ABSTRACT: An air engine is a pneumatic device that converts the energy of compressed air into useful mechanical work without combustion. It operates on the principle of expansion of compressed air, making it an environmentally friendly alternative to traditional engines. The fabrication of an air engine involves systematic design, material selection, machining, assembly, and testing processes based on concepts from Mechanical Engineering and Thermodynamics.

The fabrication process begins with the design phase, where detailed drawings and dimensions of components such as the cylinder, piston, crankshaft, connecting rod, air inlet and exhaust valves, and frame are prepared. Proper design ensures efficient air flow, minimal leakage, and smooth motion transfer. Materials like mild steel, aluminum, and cast iron are selected depending on strength, weight, cost, and machinability.

Manufacturing of individual components is carried out using conventional machining processes such as turning, milling, drilling, shaping, and grinding. The cylinder is finished with high precision to reduce friction and air leakage, while the piston is designed to fit accurately within the cylinder. The crankshaft and connecting rod are fabricated to withstand dynamic loads and ensure effective conversion of reciprocating motion into rotary motion.

Assembly is a critical stage where all components are fitted together with proper alignment. Bearings, seals, and gaskets are used to reduce friction and prevent air leakage. The compressed air supply system is connected through control valves that regulate the entry and exit of air inside the cylinder. When compressed air enters the cylinder, it pushes the piston, creating reciprocating motion. This motion is transmitted to the crankshaft, producing rotary output.

After assembly, the air engine is tested for performance, efficiency, and leakage. Adjustments are made to improve sealing, alignment, and air flow. Lubrication is provided to reduce wear and enhance durability. The overall system is evaluated based on speed, torque, and operational smoothness.

The fabricated air engine demonstrates the practical application of pneumatic systems and energy conversion principles. It offers advantages such as low pollution, simple construction, low maintenance, and safe operation. However, limitations such as lower efficiency compared to internal combustion engines and dependency on compressed air supply exist.

This project highlights the potential of air engines in small-scale applications and as a sustainable alternative for future energy systems.

KEYWORDS: Air Engine, Compressed Air Technology, Pneumatic System, Thermodynamics, Mechanical Fabrication, Energy Conversion, Chain Drive Mechanism

I. INTRODUCTION

An air engine is a type of prime mover that utilizes compressed air as its working medium to generate mechanical energy. Unlike internal combustion engines that depend on burning fossil fuels, an air engine operates on the expansion of pressurized air, making it a cleaner and safer alternative. This technology significantly reduces environmental pollution, as it produces no harmful exhaust gases. The fundamental working principle is based on the laws of Thermodynamics,

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particularly the behavior of gases under pressure and temperature changes, and is practically implemented using concepts from Mechanical Engineering.

The need for alternative energy sources has increased due to the depletion of fossil fuels and rising environmental concerns. In this context, air engines have gained attention as a sustainable solution for certain applications. They are especially suitable for low-power operations, educational models, and environments where safety is critical, such as mines or explosive atmospheres, since they eliminate the risk of fire hazards associated with fuel combustion.

The fabrication of an air engine involves a systematic approach that integrates design, material selection, manufacturing, and assembly processes. Initially, a detailed design is prepared, either manually or using computer-aided design (CAD) software. The design phase focuses on determining the dimensions, tolerances, and configuration of key components such as the cylinder, piston, crankshaft, connecting rod, flywheel, and valve system. Proper design ensures efficient air flow, reduced leakage, and smooth transmission of motion.

Material selection is another crucial aspect of fabrication. Materials such as aluminum, mild steel, and cast iron are commonly used depending on the functional requirements of each component. For instance, aluminum is preferred for pistons due to its lightweight and good thermal properties, while steel is used for crankshafts because of its high strength and durability. The selection process considers factors like cost, availability, machinability, and resistance to wear and corrosion.

The manufacturing stage involves various machining operations including turning, milling, drilling, reaming, and grinding. These processes are performed using machine tools such as lathes, milling machines, and drilling machines. High precision is required, especially in the cylinder and piston assembly, to ensure airtight sealing and efficient energy conversion. Surface finishing techniques are also applied to reduce friction and improve the overall performance of the engine.

Following fabrication, the components are assembled carefully. Proper alignment of the crankshaft, connecting rod, and piston is essential to avoid mechanical losses and vibrations. Bearings are installed to support rotating parts and reduce friction, while seals and gaskets are used to prevent leakage of compressed air. The valve mechanism is set up to control the timing of air intake and exhaust, which is critical for smooth and efficient operation.

In operation, compressed air is supplied from an external source such as an air compressor. The high-pressure air enters the cylinder through the inlet valve and expands, pushing the piston downward. This reciprocating motion is transmitted to the crankshaft via the connecting rod, converting it into rotary motion. The exhaust air is then released through an outlet valve, completing the working cycle. The addition of a flywheel helps maintain uniform motion by storing rotational energy and reducing fluctuations.

Testing and performance evaluation are conducted after assembly to ensure proper functioning. Parameters such as speed, torque, efficiency, and air consumption are measured. Any defects, such as air leakage or misalignment, are corrected during this stage. Lubrication is also applied to moving parts to minimize wear and extend the lifespan of the engine.

The fabrication of an air engine provides a comprehensive understanding of pneumatic systems and mechanical design principles. It serves as an effective educational project for students, helping them bridge the gap between theoretical knowledge and practical application. Furthermore, it highlights the importance of developing eco-friendly technologies in response to global energy challenges.

Despite its advantages, the air engine has certain limitations, including lower efficiency compared to conventional engines and reliance on a continuous supply of compressed air. However, ongoing research and technological advancements aim to overcome these challenges and improve the feasibility of air-powered systems.

In conclusion, the fabrication of an air engine is not only a valuable academic exercise but also a step toward exploring sustainable and innovative energy solutions. It demonstrates how fundamental engineering principles can be applied to develop clean, safe, and efficient mechanical systems for future applications

1.1 PROBLEM STATEMENT

The increasing dependence on conventional internal combustion engines has led to serious environmental and energy-related challenges, including air pollution, greenhouse gas emissions, and depletion of fossil fuels. These issues highlight

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the urgent need to explore alternative and sustainable energy sources. In this context, the concept of an air engine, which operates using compressed air instead of fuel, emerges as a potential solution based on the principles of Thermodynamics and Mechanical Engineering.

However, despite its advantages, the practical implementation of air engines faces several challenges. One of the main problems is the efficient conversion of compressed air energy into mechanical work. Losses due to air leakage, friction, and improper design can significantly reduce the performance of the engine. Achieving precise fabrication of components such as the piston, cylinder, and valves is essential to minimize these losses.

Another issue is the availability and maintenance of a continuous compressed air supply. Air engines require an external compressor, which may consume additional energy, thereby affecting overall system efficiency. Additionally, improper alignment and assembly of components can lead to vibrations, wear, and reduced lifespan of the engine.

The problem statement of this project, therefore, focuses on designing and fabricating a functional air engine model that can operate efficiently with minimal air leakage and mechanical losses. It aims to develop a simple, cost-effective, and reliable system that demonstrates the practical application of pneumatic power while addressing common fabrication and performance challenges.

This project also seeks to analyze the limitations of air engines and explore possible improvements in design and fabrication techniques to enhance their efficiency and usability in real-world applications.

1.2 Objectives

The main objective of fabricating an air engine is to design and develop a working model that converts the energy of compressed air into mechanical motion efficiently. This project is based on the fundamental principles of Thermodynamics and their practical application through Mechanical Engineering concepts.

One of the primary objectives is to understand the working principle of pneumatic systems and how compressed air can be used as an alternative energy source. The project aims to design key components such as the cylinder, piston, crankshaft, and valve mechanism with proper dimensions and tolerances to ensure smooth and efficient operation.

Another important objective is to gain hands-on experience in various manufacturing processes like turning, drilling, milling, and grinding. This helps in developing practical skills in machining, material selection, and component fabrication. Ensuring proper assembly and alignment of parts to minimize friction, vibration, and air leakage is also a key focus.

The project also aims to evaluate the performance of the fabricated air engine by analyzing parameters such as speed, efficiency, and air consumption. Identifying losses and suggesting improvements in design and fabrication techniques form an essential part of the study.

Additionally, the objective includes promoting awareness of eco-friendly technologies by demonstrating a system that operates without fuel combustion and produces no harmful emissions. Overall, the project seeks to bridge the gap between theoretical knowledge and practical implementation while exploring the potential of compressed air as a sustainable energy source.

II. RELATED WORK

The development of air engines and pneumatic power systems has been an area of continuous research in the fields of Thermodynamics and Mechanical Engineering. Earlier work in this domain primarily focused on the use of compressed air in industrial applications such as pneumatic tools, automation systems, and material handling equipment. These applications demonstrated that compressed air is a safe, reliable, and clean source of energy, especially in hazardous environments where the use of combustible fuels is risky.

With increasing environmental concerns and the need for sustainable energy solutions, researchers began exploring the possibility of using compressed air as a primary energy source for engines. Initial studies involved simple piston-cylinder air engines that mimicked the working of steam engines but used compressed air instead of steam. These early models helped in understanding the basic working principles and identifying key challenges such as air leakage, inefficient expansion, and mechanical losses.

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Subsequent research focused on improving the performance and efficiency of air engines. One major area of study has been the optimization of valve timing and air flow control. Proper timing of air intake and exhaust significantly affects the efficiency and smooth operation of the engine. Researchers have experimented with different valve mechanisms, including rotary valves and electronically controlled valves, to achieve better control over airflow.

Another important area of related work is the improvement of sealing and lubrication techniques. Air leakage between the piston and cylinder is a major source of energy loss. To address this, advanced sealing materials and piston ring designs have been developed. Similarly, proper lubrication methods have been studied to reduce friction and wear, thereby enhancing the durability and performance of the engine.

Material selection has also been widely researched. Lightweight materials such as aluminum alloys are commonly used for pistons and other moving parts to reduce inertia and improve efficiency. High-strength materials like steel are used for components subjected to heavy loads, such as crankshafts and connecting rods. Some studies have even explored the use of composite materials to further improve performance.

In addition to conventional reciprocating air engines, alternative designs such as rotary air engines and multi-stage expansion engines have been investigated. Rotary air engines eliminate the need for reciprocating parts, thereby reducing vibration and mechanical losses. Multi-stage expansion systems aim to extract more energy from compressed air by allowing it to expand in multiple stages, improving overall efficiency.

Researchers have also utilized computational tools and simulation software to analyze the behavior of air engines. Parameters such as pressure variation, temperature changes, air flow dynamics, and stress distribution are studied using modeling techniques. These simulations help in optimizing design parameters before fabrication, reducing trial-and-error efforts and improving overall design accuracy.

Some studies have explored hybrid systems that combine compressed air with other energy sources, such as electric or thermal systems, to overcome the limitations of standalone air engines. These hybrid approaches aim to enhance efficiency and extend the range of applications.

Despite these advancements, the literature highlights several persistent challenges, including low energy efficiency, dependency on external air compressors, and energy losses during compression and expansion. However, the simplicity, safety, and environmental benefits of air engines continue to drive research in this field.

The present project builds upon these existing works by focusing on the fabrication of a simple, cost-effective air engine model. It aims to demonstrate the practical working of compressed air systems, analyze performance limitations, and suggest improvements in design and fabrication techniques for better efficiency and reliability.

III. EXISTING METHODOLOGY

The existing methodology for fabricating an air engine is a structured engineering approach that combines design principles, manufacturing processes, and assembly techniques based on Mechanical Engineering and the energy transformation concepts of Thermodynamics. It is commonly used in academic projects, prototype development, and basic pneumatic system studies.

The methodology begins with the **design phase**, which is the most critical step. In existing practices, the air engine is typically designed as a single-cylinder reciprocating system for simplicity. The layout includes essential components such as the cylinder, piston, crankshaft, connecting rod, inlet and exhaust valves, flywheel, and supporting frame. Design considerations focus on stroke length, bore diameter, valve timing, and material thickness. In many traditional approaches, manual sketches or basic CAD models are used to define the geometry and ensure proper alignment of moving parts.

Following the design stage is **material selection**, where suitable materials are chosen based on mechanical properties and cost efficiency. Aluminum alloys are commonly used for pistons due to their low weight and good thermal conductivity, which helps in smooth reciprocating motion. Mild steel is preferred for structural components like the frame, crankshaft, and connecting rod because of its strength and ability to withstand cyclic loading. In some improved methodologies, surface coatings or hardened materials are used to reduce wear and extend service life.

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The **manufacturing stage** involves converting the design into physical components using conventional machining operations. Processes such as turning are used to shape cylindrical parts, milling is used for flat surfaces and slots, drilling is used for creating holes for joints and fasteners, and grinding is applied for finishing and achieving high precision. In basic existing setups, manually operated machines are widely used, while advanced institutions may use CNC machining for better accuracy and repeatability. Special attention is given to the piston-cylinder assembly, as even small dimensional errors can lead to air leakage and reduced efficiency.

After fabrication, the **assembly process** is carried out in a sequential manner. The crankshaft is mounted on bearings to ensure smooth rotation, followed by the installation of the connecting rod and piston assembly. The piston is fitted carefully into the cylinder with proper clearance to maintain airtight conditions while minimizing friction. Sealing elements such as piston rings or rubber gaskets are used to reduce leakage of compressed air. The valve mechanism is then integrated to control the precise timing of air intake and exhaust, which directly affects engine performance. A flywheel is usually attached to the crankshaft to stabilize motion and maintain continuous rotation by storing kinetic energy.

Once assembly is complete, the system undergoes **operation and testing**. Compressed air from an external source such as an air compressor is supplied to the engine. The air enters the cylinder through the inlet valve, expands, and forces the piston to move linearly. This reciprocating motion is converted into rotary motion through the crankshaft mechanism. The exhaust air is released through an outlet valve, completing the cycle. During testing, key performance parameters such as rotational speed, torque output, air consumption rate, vibration levels, and leakage losses are measured.

The **evaluation stage** is essential in existing methodology to identify design limitations. Common issues include air leakage due to poor sealing, frictional losses between moving parts, misalignment of components, and low overall energy efficiency. Adjustments such as improving fit tolerances, enhancing lubrication, and refining valve timing are often made to improve performance

IV. PROPOSED METHODOLOGY

The proposed methodology for fabricating an air engine focuses on improving efficiency, reducing air leakage, and enhancing overall performance compared to the existing conventional approaches. It is based on engineering principles of Mechanical Engineering and energy conversion concepts from Thermodynamics, with an emphasis on better design precision, advanced materials, and optimized fabrication techniques.

The process begins with an **advanced design phase**, where modern CAD software is used to create a highly accurate 3D model of the air engine. Unlike traditional single-cylinder designs, the proposed system may include improved configurations such as multi-cylinder arrangements or optimized single-cylinder layouts with better valve timing mechanisms. Key parameters like pressure ratio, stroke length, bore size, and air flow rate are carefully analyzed using simulation tools to predict performance before fabrication.

A major improvement in the proposed methodology is the use of **simulation and analysis tools**. Computational methods are applied to study airflow behavior, pressure distribution, and thermal effects inside the cylinder. This helps in identifying potential energy losses and optimizing component geometry to achieve better efficiency and smoother operation.

During **material selection**, advanced and lightweight materials such as aluminum alloys, composite materials, or treated steels are recommended to reduce inertia and wear. Improved sealing materials like high-performance elastomers or Teflon-based rings are proposed to minimize air leakage and increase compression efficiency.

The **manufacturing stage** in the proposed methodology emphasizes precision machining using CNC machines instead of manual processes. CNC machining ensures higher dimensional accuracy, better surface finish, and improved consistency in components such as the piston, cylinder, and crankshaft. Additive manufacturing (3D printing) can also be considered for prototyping complex parts, reducing fabrication time and cost.

In the **assembly stage**, greater attention is given to alignment accuracy and sealing efficiency. Precision bearings are used to reduce friction, while advanced sealing techniques are implemented to prevent pressure losses. The valve system is redesigned using optimized timing mechanisms, such as electronically controlled or rotary valves, to ensure better air intake and exhaust control.

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The **control and operation phase** in the proposed methodology may include the integration of sensors and monitoring systems to measure pressure, speed, and efficiency in real time. This allows performance tracking and further optimization during operation. The use of improved flywheel design also helps maintain smoother and more stable motion.

Finally, in the **testing and optimization stage**, performance is evaluated under different pressure conditions, and data is analyzed to identify areas for improvement. Iterative modifications are made to enhance efficiency, reduce leakage, and improve durability.

Overall, the proposed methodology aims to overcome the limitations of traditional fabrication methods by introducing precision design, advanced materials, and modern manufacturing technologies. It results in a more efficient, reliable, and performance-optimized air engine suitable for experimental, educational, and potential small-scale practical applications.

Chain drive is a way of transmitting mechanical power from one place to another. It is often used to convey power to the wheels of a vehicle, particularly bicycles and motorcycles. It is also used in a wide variety of machines besides vehicles.

Most often, the power is conveyed by a roller chain, known as the **drive chain** or **transmission chain**, passing over a sprocket gear, with the teeth of the gear meshing with the holes in the links of the chain. The gear is turned, and this pulls the chain putting mechanical force into the system.

Sometimes the power is output by simply rotating the chain, which can be used to lift or drag objects. In other situations, a second gear is placed and the power is recovered by attaching shafts or hubs to this gear. Though drive chains are often simple oval loops, they can also go around corners by placing more than two gears along the chain; gears that do not put power into the system or transmit it out are generally known as idler-wheels. By varying the diameter of the input and output gears with respect to each other, the gear ratio can be altered. For example, when the bicycle pedals' gear rotate once, it causes the gear that drives the wheels to rotate more than one revolution.

Characteristics:
- High axial stiffness
- Low bending stiffness
- High efficiency
- Relatively cheap

Chain drive design calculation:
- Chain length and centre distance
- Chain must contain even integer number of links
- Hence cannot pick an arbitrary centre distance and chain pitch
- Nearest chain lengths (in pitches) for a contemplatedcentre distance, C_C, are calculated by empirical formulae like (for a two sprocket system:

L = N1+N2/2 + 2Cc/p + (N2-N1) ^2/4pi^2Cc

Where N_1 and N_2 are the numbers of teeth on sprockets and P is the chain pitch

Inertial force in chain
- In addition to the tension required to transmit power, chain tension
- also provides centripetal force to move links around sprockets
- The extra inertial force, Fcf, is given by:

F = mr ^2w ^2

A sprocket or sprocket-wheel is a profiled wheel with teeth, or cogs, that mesh with a chain, track or other perforated or indented material. The name 'sprocket' applies generally to any wheel upon which radial projections engage a chain passing over it. It is distinguished from a gear in that sprockets are never meshed together directly, and differs from a pulley in that sprockets have teeth and pulleys are smooth.

Sprockets are used in bicycles, motorcycles, cars, tracked vehicles, and other machinery either to transmit rotary motion between two shafts where gears are unsuitable or to impart linear motion to a track, tape etc. Perhaps the most common form of sprocket may be found in the bicycle, in which the pedal shaft carries a large sprocket-wheel, which drives a

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chain, which, in turn, drives a small sprocket on the axle of the rear wheel . Early automobiles were also largely driven by sprocket and chain mechanism, a practice largely copied from bicycles.

16 tooth sprocket. Do = Sprocket diameter. Dp = Pitch diameter

Sprockets are of various designs, a maximum of efficiency being claimed for each by its originator. Sprockets typically do not have a flange. Some sprockets used with timing belts have flanges to keep the timing belt centered. Sprockets and chains are also used for power transmission from one shaft to another where slippage is not admissible, sprocket chains being used instead of belts or ropes and sprocket-wheels instead of pulleys. They can be run at high speed and some forms of chain are so constructed as to be noiseless even at high speed.

ETYMOLOGY

The term 'sprocket' originally applied to the projection from the wheel that caught on the chain and provided the drive to it. The overall wheel was then termed a 'sprocket wheel'. With time and common use of these devices, the overall wheel became known as a sprocket. The earlier uses would now be seen as archaic.

TRANSPORTATION

In the case of bicycle chains, it is possible to modify the overall gear ratio of the chain drive by varying the diameter (and therefore, the tooth count) of the sprockets on each side of the chain. This is the basis of derailleur gears. A multi-speed bicycle, by providing two or three different-sized driving sprockets and up to 11 (as of 2014) different-sized driven sprockets, allows up to 33 different gear ratios. The resulting lower gear ratios make the bike easier to pedal up hills while the higher gear ratios make the bike more powerful to pedal on flats and downhills. In a similar way, manually changing the sprockets on a motorcycle can change the characteristics of acceleration and top speed by modifying the final drive gear ratio.

TRACKED VECHILE

In the case of vehicles with caterpillar tracks the engine-driven toothed-wheel transmitting motion to the tracks is known as the drive sprocketand may be positioned at the front or back of the vehicle, or in some cases both. There may also be a third sprocket, elevated, driving the track.

Moving picture mechanism from 1914. The sprocket wheels a, b, and c engage and transport the film. a and b move with uniform velocity and c indexes each frame of the film into place for projection.

Sprockets are used in the film transport mechanisms of movie projectors and movie cameras. In this case, the sprocket wheels engage film perforations in the film stock. Sprocket feed was also used for punched tape and is used for paper feed to some computer printers.

Chain drive is a way of transmitting mechanical power from one place to another. It is often used to convey power to the wheels of a vehicle, particularly bicycles and motorcycles. It is also used in a wide variety of machines besides vehicles.

Most often, the power is conveyed by a roller chain, known as the drive chain or transmission chain, passing over a sprocket gear, with the teeth of the gear meshing with the holes in the links of the chain. The gear is turned, and this pulls the chain putting mechanical force into the system. Another type of drive chain is the Morse chain, invented by the Morse Chain Company of Ithaca, New York, United States. This has inverted teeth.

Sometimes the power is output by simply rotating the chain, which can be used to lift or drag objects. In other situations, a second gear is placed and the power is recovered by attaching shafts or hubs to this gear. Though drive chains are often simple oval loops, they can also go around corners by placing more than two gears along the chain; gears that do not put power into the system or transmit it out are generally known as idler-wheels. By varying the diameter of the input and output gears with respect to each other, the gear ratio can be altered. For example, when the bicycle pedals' gear rotate once, it causes the gear that drives the wheels to rotate more than one revolution.

The first continuous and endless power-transmitting chain was depicted in the written horological treatise of the Song Dynasty (960–1279) Chinese engineer Su Song (1020-1101 AD), who used it to operate the armillary sphere of his astronomical clock tower as well as the clock jack figurines presenting the time of day by mechanically banging gongs and drums. The chain drive itself was given power via the hydraulic works of Su's water clock tank and waterwheel, the latter which acted as a large gear.

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ROLLER CHAIN

Roller chain and sprockets is a very efficient method of power transmission compared to (friction-drive) belts, with far less frictional loss.

Although chains can be made stronger than belts, their greater mass increases drive train inertia.

Drive chains are most often made of metal, while belts are often rubber, plastic, urethane, or other substances.

Drive belts can slip unless they have teeth, which means that the output side may not rotate at a precise speed, and some work gets lost to the friction of the belt as it bends around the pulleys. Wear on rubber or plastic belts and their teeth is often easier to observe, and chains wear out faster than belts if not properly lubricated.

One problem with roller chains is the variation in speed, or surging, caused by the acceleration and deceleration of the chain as it goes around the sprocket link by link. It starts as soon as the pitch line of the chain contacts the first tooth of the sprocket. This contact occurs at a point below the pitch circle of the sprocket. As the sprocket rotates, the chain is raised up to the pitch circle and is then dropped down again as sprocket rotation continues. Because of the fixed pitch length, the pitch line of the link cuts across the chord between two pitch points on the sprocket, remaining in this position relative to the sprocket until the link exits the sprocket. This rising and falling of the pitch line is what causes chordal effect or speed variation.

In other words, conventional roller chain drives suffer the potential for vibration, as the effective radius of action in a chain and sprocket combination constantly changes during revolution ("Chordal action"). If the chain moves at constant speed, then the shafts must accelerate and decelerate constantly. If one sprocket rotates at a constant speed, then the chain (and probably all other sprockets that it drives) must accelerate and decelerate constantly. This is usually not an issue with many drive systems; however, most motorcycles are fitted with a rubber bushed rear wheel hub to virtually eliminate this vibration issue. Toothed belt drives are designed to avoid this issue by operating at a constant pitch radius.

Chains are often narrower than belts, and this can make it easier to shift them to larger or smaller gears in order to vary the gear ratio. Multi-speed bicycles with derailleurs make use of this. Also, the more positive meshing of a chain can make it easier to build gears that can increase or shrink in diameter, again altering the gear ratio. However, some newer synchronous belts claim to have "equivalent capacity to roller chain drives in the same width".

Both can be used to move objects by attaching pockets, buckets, or frames to them; chains are often used to move things vertically by holding them in frames, as in industrial toasters, while belts are good at moving things horizontally in the form of conveyor belts. It is not unusual for the systems to be used in combination; for example the rollers that drive conveyor belts are themselves often driven by drive chains.

Drive shafts are another common method used to move mechanical power around that is sometimes evaluated in comparison to chain drive; in particular belt drive vs chain drive vs shaft drive is a key design decision for most motorcycles. Drive shafts tend to be tougher and more reliable than chain drive, but the bevel gears have far more friction than a chain. For this reason virtually all high-performance motorcycles use chain drive, with shaft-driven arrangements generally used for non-sporting machines. Toothed-belt drives are used for some (non-sporting) models.

USES IN VEHICLES

Chain drive was the main feature which differentiated the safety bicycle introduced in 1885, with its two equal-sized wheels, from the direct-drive penny-farthing or "high wheeler" type of bicycle. The popularity of the chain-driven safety bicycle brought about the demise of the penny-farthing, and is still a basic feature of bicycle design today.

AUTOMOBILES

Mack AC delivery truck at the Petersen Automotive Museum with chain drive visible

Chain drive was a popular power transmission system from the earliest days of the automobile. It gained prominence as an alternative to the Système Panhard with its rigid Hotchkiss driveshaft and universal joints.

A chain-drive system uses one or more roller chains to transmit power from a differential to the rear axle. This system allowed for a great deal of vertical axle movement (for example, over bumps), and was simpler to design and build than a rigid driveshaft in a workable suspension. Also, it had less unsprung weight at the rear wheels than the Hotchkiss drive, which would have had the weight of the driveshaft and differential to carry as well. This meant that the vehicle would have a smoother ride. The lighter unsprung mass would allow the suspension to react to bumps more effectively.

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Frazer Nash were strong proponents of this system using one chain per gear selected by dog clutches. The Frazer Nash chain drive system, (designed for the GN Cyclecar Company by Archibald Frazer-Nash and Henry Ronald Godfrey) was very effective, allowing extremely fast gear selections. The Frazer Nash (or GN) transmission system provided the basis for many "special" racing cars of the 1920s and 1930s, the most famous being Basil Davenport's Spider which held the outright record at the Shelsley Walsh Speed Hill Climb in the 1920s.
The last popular chain drive automobile was the Honda S600 of the 1960s.

IN ENGINES
Internal combustion engines often use a timing chain to drive the camshaft(s). This is an area in which chain drives frequently compete directly with timing belt drive systems, particularly when the engine has one or more overhead camshafts, and provides an excellent example of some of the differences and similarities between the two approaches. For this application, chains last longer, but are often harder to replace, as they must be enclosed in a space into which lubricating oil can be introduced. Being heavier, the chain robs more power, but is also less likely to fail. The camshaft of a four stroke engine rotates at half crankshaft speed, so the camshaft sprocket has twice as many teeth as the crankshaft sprocket. Less common alternatives to timing chain drives include spur gears or bevel gears combined with a shaft.

TRANSFER CASES
Today, inverted tooth drive chains are commonly used in passenger car and light truck transfer cases.

MOTORCYCLES
Chain drive versus belt drive or use of a driveshaft is a fundamental design decision in motorcycle design; nearly all motorcycles use one of these three designs. See Motorcycle construction
Final drive for more details.

Air tank
Diving cylinder, used by scuba divers to hold *air* and other breathing gases at high pressure underwater; Pneumatic pressure vessel, for storing compressed *air* to operate equipment such as braking systems, paint dispensers and paintball guns, Air tank is also air compressor.

Air Compressor
An air compressor is a device that converts power (using an electric motor, diesel or gasoline engine, etc.) into potential energy stored in pressurized air (i.e., compressed air). By one of several methods, an air compressor forces more and more air into a storage tank, increasing the pressure. When tank pressure reaches its engineered upper limit the air compressor shuts off. The compressed air, then, is held in the tank until called into use.[1] The energy contained in the compressed air can be used for a variety of applications, utilizing the kinetic energy of the air as it is released and the tank depressurizes. When tank pressure reaches its lower limit, the air compressor turns on again and re-pressurizes the tank.

An air compressor must be differentiated from an air pump which merely pumps air from one context into another. Air pumps do not contain an air tank for storing pressurized air and are generally much slower, quieter, and less expensive to own and operate than an air compressor.

Compressor
A compressor is a mechanical device that increases the pressure of a gas by reducing its volume. An air compressor is a specific type of gas compressor.

Compressors are similar to pumps: both increase the pressure on a fluid and both can transport the fluid through a pipe. As gases are compressible, the compressor also reduces the volume of a gas. Liquids are relatively incompressible; while some can be compressed, the main action of a pump is to pressurize and transport liquids.

Displacement type
There are numerous methods of air compression, divided into either positive-displacement or roto-dynamic types.

Positive displacement
Positive-displacement compressors work by forcing air into a chamber whose volume is decreased to compress the air. Once the maximum pressure is reached, a port or valve opens and air is discharged into the outlet system from the compression chamber.[4] Common types of positive displacement compressors are

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- Piston-type: air compressors use this principle by pumping air into an air chamber through the use of the constant motion of pistons. They use one-way valves to guide air into and out of a chamber whose base consists of a moving piston. When the piston is on its down stroke, it draws air into the chamber.
- It up stroke, the charge of air is forced out and into a storage tank. Piston compressors generally fall into two basic categories, single-stage and two-stage. Single stage compressors usually fall into the fractional through 5 horsepower range. Two-stage compressors normally fall.
- Into the 5 through 30 horsepower range. Two-stage compressors provide greater efficiency than their single-stage counterparts. For this reason, these compressors are the most common units within the small business community.
- The capacities for both single-stage and two-stage compressors is generally provided in horsepower (HP), Standard Cubic feet per Minute (SCFM)* and Pounds per Square Inch (PSI). *To a lesser extent, some compressors are rated in Actual Cubic Feet per Minute (ACFM). Still others are rated in Cubic Feet per Minute(CFM). Using CFM to rate a compressor is incorrect because it represents a flow rate that is independent of a pressure reference. i.e. 20 CFM *at 60 PSI.*
- Rotary screw compressors: use positive-displacement compression by matching two helical screws that, when turned, guide air into a chamber, whose volume is decreased as the screws turn.
- Vane compressors: use a slotted rotor with varied blade placement to guide air into a chamber and compress the volume. This type of compressor delivers a fixed volume of air at high pressures.

Dynamic displacement

- Dynamic displacement air compressors include centrifugal compressors and axial compressors. In these types, a rotating component imparts its kinetic energy to the air which is eventually converted into pressure energy. These use centrifugal force generated by a spinning impeller to accelerate and then decelerate captured air, which pressurizes it.

Cooling

Due to adiabatic heating, air compressors require some method of disposing of waste heat. Generally this is some form of air- or water-cooling, although some particularly rotary type compressors may be cooled by oil that is then in turn air- or water-cooled and the atmospheric changes also considered during cooling of compressors.

Application

Air compressors have many uses, including: supplying high-pressure clean air to fill gas cylinders, supplying moderate-pressure clean air to a submerged surface supplied diver, supplying moderate-pressure clean air for driving some office and school Building pneumatic HVAC control system valves, supplying a large amount of moderate-pressure air to power pneumatic tools, such as jackhammers, filling high pressure air tanks (HPA), for filling tires, and to produce large volumes of moderate-pressure air for large-scale industrial processes such as oxidation for petroleum coking or cement plant bag house purge systems.

Most air compressors either are reciprocating piston type, rotary vane or rotary screw. Centrifugal compressors are common in very large applications. There are two main types of air-compressor pumps: oil-lubed and oil-less. The oil-less system has more technical development, but is more expensive, louder and lasts for less time than oil-lubed pumps. The oil-less system also delivers air of better quality.

The most common types of air compressors are: electric or gas/diesel powered compressors. The power of a compressor is measured in HP (horsepower) and CFM cubic feet per minute of intake air. The gallon size of the tank specifies the volume of compressed air in reserve available. Gas/diesel powered compressors are widely used in remote areas with problematic access to electricity. They are noisy and require ventilation for exhaust gases. Electric powered compressors are widely used in production, workshops and garages with permanent access to electricity. Common workshop/garage compressors are 110-120 Volt or 230-240 Volt. Compressor tank shapes are: "pancake", "twin tank", "horizontal", and "vertical". Depending on a size and purpose compressors can be stationary or portable.

Specification Obviously, a compressor that requires 5 HP to deliver 16 CFM is not as efficient as a 4 HP compressor that can produce the same amount of air.PSIG, or pounds per square inch gauge, is probably the most important specification after CFM. Psig is a unit of pressure relative to the surrounding atmosphere.

V. CONCLUSION

The fabrication of an air engine demonstrates a practical application of pneumatic energy conversion, where compressed air is effectively transformed into mechanical work without the use of fuel combustion. This project is strongly based on

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the principles of Thermodynamics and implemented through design and manufacturing concepts in Mechanical Engineering.

Through this work, it is observed that an air engine can be successfully designed and fabricated using basic mechanical components such as a cylinder, piston, crankshaft, connecting rod, and valve system. The proper selection of materials, accurate machining, and careful assembly play a crucial role in ensuring smooth operation and minimizing losses such as air leakage and friction.

The project also highlights the importance of precision in manufacturing and alignment of components, as even small errors can significantly affect performance. Testing results show that the engine is capable of producing rotary motion from compressed air, confirming the feasibility of the concept for small-scale applications.

In addition, this fabrication process provides valuable hands-on experience in machining, assembly, and system integration. It helps in understanding real-world engineering challenges such as efficiency loss, pressure control, and mechanical wear. The study also emphasizes the need for improved design techniques and better sealing methods to enhance overall performance.

Although the air engine has limitations such as lower efficiency compared to conventional engines and dependence on an external compressed air source, its advantages include zero emissions, low maintenance, safety, and simple construction. These features make it suitable for educational purposes and experimental setups.

In conclusion, the fabrication of an air engine successfully demonstrates an eco-friendly alternative energy system and bridges the gap between theoretical knowledge and practical engineering application. It also opens opportunities for further research and development aimed at improving efficiency and expanding its real-world usability.

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